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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

TIT3131 – INFORMATION THEORY (All sections / Groups)

25 October 2018
9.00 am – 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with **Five** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

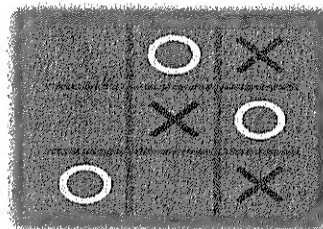
- (a) Information sources have two categories. Classify the information sources for 'A' and 'B' in Table 1 with their respective descriptions.

<i>Information Sources</i>	<i>Descriptions</i>
<i>A</i>	<i>A current symbol depends on the previous symbols.</i>
<i>B</i>	<i>Each symbol produced is independent of the previous symbols.</i>

Table 1

[2 marks]

- (b) A source emits one of SEVEN possible symbols from a Tic-Tac-Toe game. Figure 1 shows SIX available symbols and one more symbol is pending at the next move. Given that the probability of Player 'X' win this game is higher than player 'O' at the next move.

**Figure 1**

- i. Show the amount of information for the symbol "X" and "O" in the next move.

k	1	2
S_k	$S_1 = 'X'$	$S_2 = 'O'$
P_k		
$I(S_k)$		

[4 marks]

- ii. From part (i), what is the relation between P_k and $I(S_k)$ and also their relation with entropy? [2 marks]
- iii. Show the information rate of this source if one of the SEVEN symbols is emitted, once every microsecond. [4 marks]

Continued...

QUESTION 2

- (a) Consider a discrete memoryless source with source alphabet $\{S_0, S_1, S_2\}$ with probabilities $P_0 = 0.4$, $P_1 = x$, $P_2 = x$. Show that the second-order extension of the source $H(S^2) = 2H(S)$. [6 marks]
- (b) Consider the following text fragment:

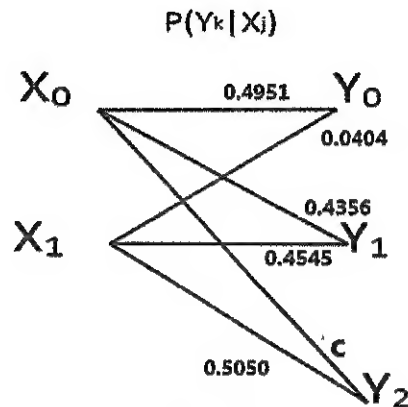
JEALOUSYAA

The text fragment above contains 10 characters.

- i. Construct a Huffman code for the text. [3 marks]
- ii. Show your steps to demonstrate the average length of the Huffman codes and also the efficiency of the code. [3 marks]

QUESTION 3

- (a) A source X produces letters from a two symbol alphabet with the probability assignment $P_x(0) = 0.505$ and $P_x(1) = 0.495$. Each source letter x is transmitted through a channel as shown in **Figure 2** and the transition probabilities are indicated as below.

**Figure 2**

- i. From **Figure 2**, what is the value of c ? Prepare the conditional probability $P(y|x)$ and joint probability tables $P(y,x)$.
[5 marks]
 - ii. Write all the steps to show that $I(Y,X)$ equal to $I(X,Y)$.
[5 marks]
- (b) Illustrate the meaning of prefix code using **TWO** suitable source codes in Table 2 below.

Symbols	Code 1	Code 2
A		
B		
C		
D		
Conclusion	Prefix Code	Non-prefix code

Table 2

[2 marks]

QUESTION 4

Consider the generator polynomial for a (8, 4) cyclic code generated by

$$g(D) = 1 + D + D^2 + D^4$$

- (a) Construct the encoder circuit for this code.

[5 Marks]

- (b) Construct the generator matrix, G in "systematic" form.

[3 Marks]

- (c) Construct all the valid code words for the following messages in "non-systematic" form. Show your steps.

Message	$m(D)$	$c(D)$	Code word
1100			
1111			

[2 Marks]

- (d) Construct all the valid code words for the following messages in "systematic" form. Show your steps.

Message	$m(D)$	$c(D)$	Code word
0001			
0011			

[2 marks]

QUESTION 5

Given convolutional code of path 1 and path 2 as follows:

$$\begin{aligned}g_1 &= [1,1,1], \\g_2 &= [1,1,0]\end{aligned}$$

- (a) Illustrate the convolutional encoder corresponding to the codes. [4 marks]
- (b) Construct the code tree for this encoder with depth of 4 branches. [3 marks]
- (c) Trace the path of the code tree from **Question 5(b)** corresponds to the message sequence 0011 and show the output sequence. [2 marks]
- (d) Illustrate the state diagram of the convolutional code above. [3 marks]

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